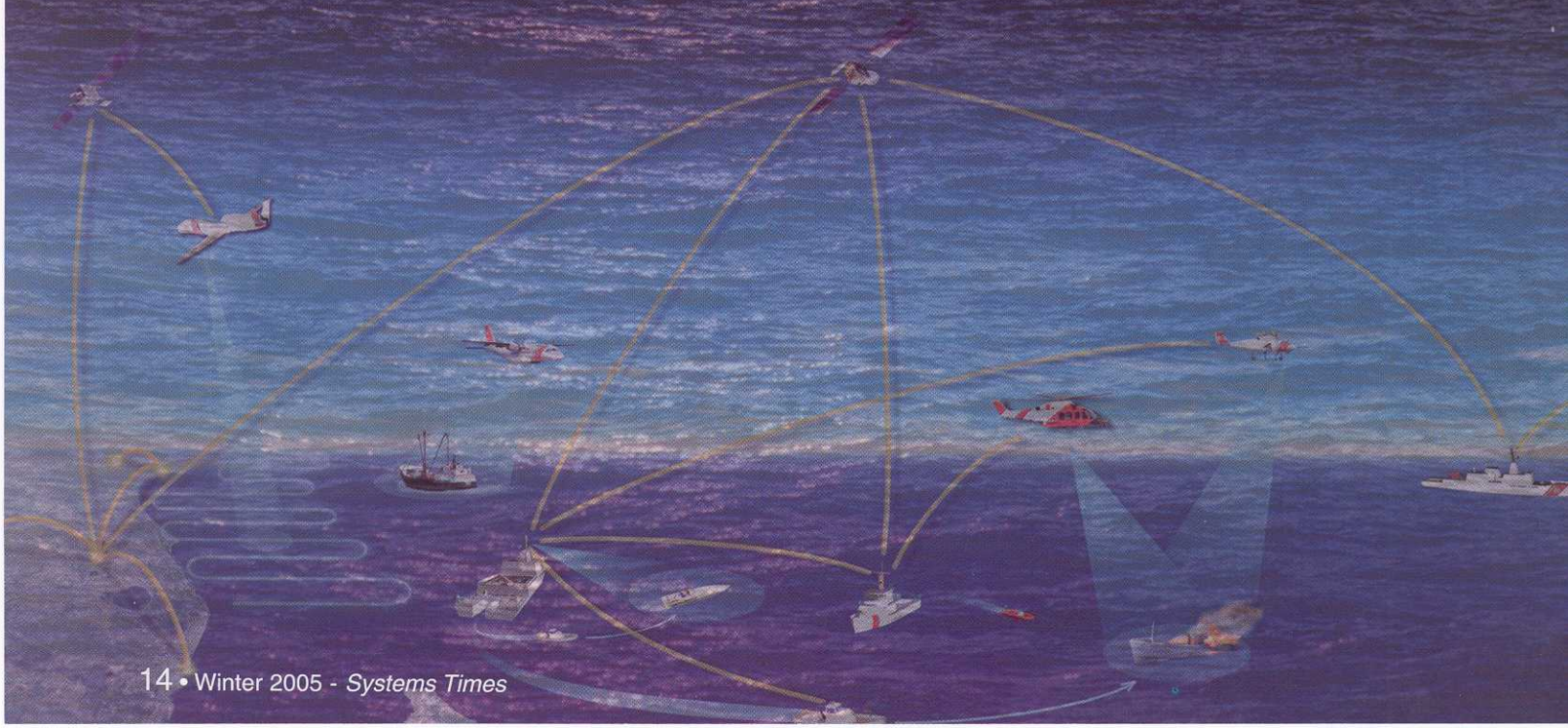
Systems

Welcome to DEEPWATER



Engineering:

Designing Deepwater's System of Systems

by **Mark D. Gaspar and Gordon I. Peterson**

The Integrated Deepwater System's (IDS) recapitalization of the Coast Guard's aging inventory of cutters, aircraft and supporting systems is remarkable in many respects, but its overarching construct as a system of systems promises to improve the effectiveness of Coast Guard operations at an affordable cost in ways that are not fully appreciated today.

"When Deepwater is complete," said Coast Guard Commandant ADM Thomas H. Collins, "our cutters and aircraft will no longer operate as independent platforms with only limited awareness of what surrounds them in the maritime domain.

ADM Collins continued, "Instead, they will have the benefit of receiving information from a wide array of mission-capable platforms and sensors-enabling them to share a common operating picture as part of a network-centric force operating in tandem with other cutters, boats, and both manned aircraft and unmanned aerial vehicles."

The Deepwater system of systems is a collection of different elements that together produce results not obtainable by the individual elements alone. These include platform systems (aircraft, cutters and patrol boats), subsystems (radars, radios, satellite communications, etc.), as well as individual components and assets (people, hardware, software, shore facilities).

All elements combine to generate capabilities needed to produce system-wide results. The value added by the system as a whole, beyond that contributed independently by its individual elements, is created by the integration among the elements (i.e., how they are interconnected and combined in order to work together).

The Commandant recently described the Deepwater Program as the "future of the Coast Guard" in a recent "ALCOAST" message. "Keeping Deepwater on track is one of my highest priorities," he said. In this regard, systems engineering plays a critical role in achieving the Commandant's goals. It is the foundation for the design, development and deployment of the Deepwater system of systems -- a Coast Guard-industry team effort, with the Coast Guard first defining operational environments and system-wide performance objectives.

It then falls to Deepwater's partner in industry and systems integrator, Integrated Coast Guard Systems (ICGS, a joint venture between Lockheed Martin and Northrop Grumman), to apply a systems-engineering approach to meet those objectives.

The result will be a transformation of today's Coast Guard to a 21st-century force employing more capable platforms, sensors and systems -- a force able to sustain operational readiness at needed levels and to implement the Coast Guard's maritime strategy and acquire maritime domain awareness more effectively at an affordable cost.

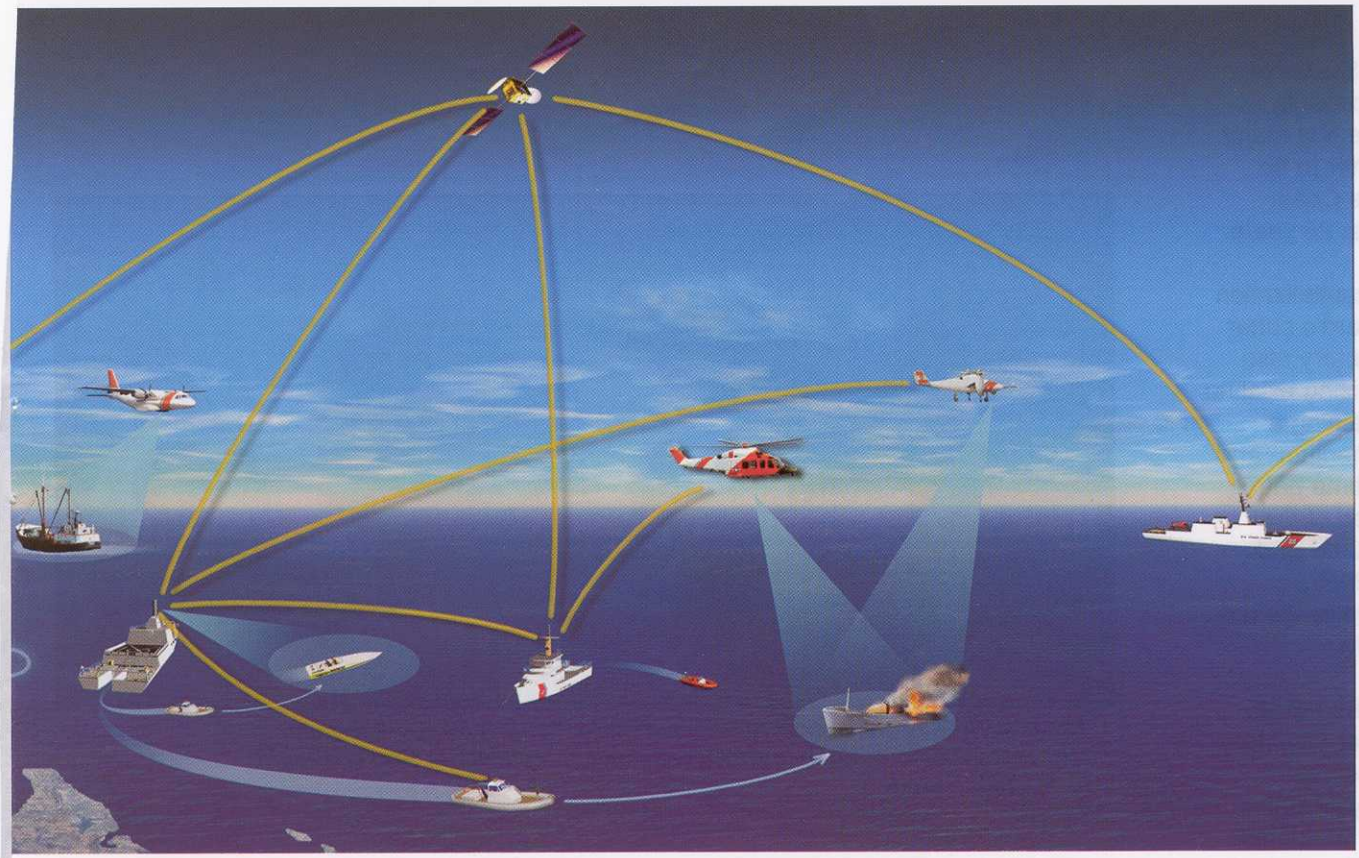
Momentum is Growing

Conceived during the late 1990s to recapitalize an aging and increasingly obsolete inventory of cutters and aircraft, the Deepwater Program has assumed an even greater sense of urgency since 9/11. Deepwater's three new classes of more capable cutters and associated small boats, manned and unmanned aircraft, integrated logistics and an improved system for C4ISR (command, control, communications, computers, intelligence, surveillance and reconnaissance) will result in a vastly more capable and effective Coast Guard -- a force better able to safeguard maritime security in U.S. ports, coastal waters and open ocean.

As ADM Collins said earlier this year, "With 9/11 came the imperative to identify and reduce security gaps in the maritime. It is essential that we get this right -- the maritime sector is one of the most valuable and vulnerable components of our transportation system."

The multiyear Deepwater Program, formally launched more than two years ago with a contract awarded to ICGS, has gained added momentum in recent months. In June [2004], the Coast Guard awarded contracts for two of the Deepwater Program's three new cutters. The first contract began the design and final requirements work for the Maritime Security Cutter, Medium (WMSM, formerly known as the Offshore Patrol Cutter). The contract will advance the medium-sized cutter's original 2012 planned delivery schedule by a full three years.

Four days later, a contract totaling $140 million also was awarded to ICGS for the production and delivery of the first Maritime Security Cutter, Large (WMSL, formerly known as the National Security Cutter). Fabrication of the first-in-class of Deepwater's largest cutter began in early September [2004] at Northrop



A multifaceted systems-engineering approach guides the design, development, and implementation of the Deepwater Program's system-of-systems acquisition strategy. USCG/RICH DOYLE

With Northrop Grumman Ship Systems burner specialist Paul Bosarge (second from left) assisting, Deepwater's Coast Guard-industry team marked the first cut of steel for the Maritime Security Cutter, Large at the Northrop Grumman Ship Systems shipyard in Pascagoula, Miss., in September 2004. Shown here from left are: RADM Patrick M. Stillman, program executive officer for the Integrated Deepwater System; Paul Bosarge; Dr.Philip A. Dur, president, Northrop Grumman Ship Systems; and Fred Moosally, president, Lockheed Martin Maritime Systems and Sensors. NGSS

Grumman Ship System's shipyard in Pascagoula, Mississippi -- the first major multimission cutter to be introduced to the Coast Guard in the past 25 years.

Deepwater's recapitalization of the Coast Guard's cutter and aircraft inventory also calls for modernizing existing assets and sustaining a mixed force of medium- and long-range maritime patrol aircraft composed of the CASA CN235-300M and upgraded HC-130H/J search-and-surveillance aircraft, respectively.

Re-engining of the HH-65 Dolphin helicopter inventory began earlier this year [2004] to remedy chronic engine reliability problems. ICGS successfully conducted initial flight tests of the first re-engined HH-65C at the Coast Guard's Aircraft Repair and Supply Center in Elizabeth City, North Carolina on August 27. Coast Guard and industry test pilots were impressed with the aircraft's increased power, speed and maneuverability.

The first HH-65C helicopter re-engined under the Deepwater Program, shown here before repainting, successfully completed its first test flight in August. ICGS

The Integrated Deepwater System will deploy both modernized and new manned and unmanned aviation platforms, including the Eagle Eye tiltrotor vertical takeoff-and-landing unmanned aerial vehicle, shown here in an industry mock-up. Bell Helicopter

A Force Multiplier

In the context of maritime homeland security, particularly in ports and coastal areas, one of Deepwater's most significant capability enhancements will be its robust C4ISR system. It is a fundamental building block in improving the Coast Guard's ability to maintain Maritime Domain Awareness (MDA) focused on meeting the needs of decision makers engaged in operations at sea, ashore and in the air.

The network-wide system is

being designed to ensure the Coast Guard will possess and maintain seamless interoperability with the forces and agencies of the Department of Homeland Security, the Department of Defense (DoD), and other federal and regional agencies -- a true force multiplier in the fullest sense.

This critical element in Deepwater's system of systems network also has marked several important milestones. Last year, the Coast Guard cutter USCGC NORTHLAND received the first in a series of enhancements and communication-systems upgrades for 270-foot medium endurance legacy cutters.

NORTHLAND and the Coast Guard's 12 other medium-endurance cutters now boast improved performance within existing communications systems and additional access to a variety of intelligence and data sources previously unavailable. Enhanced capabilities now provide these cutters access to classified and unclassified data communications through international maritime Satellite B services connectivity to the DoD Secret Internet Protocol Network (SIPRNET).

Additional future enhancements include doubling the data bandwidth and improving variable bandwidth efficiency, improvements that will enable cutters to exchange and process information more rapidly. Similar upgrades to the Coast Guard's inventory of twelve 378-foot high endurance cutters and fourteen 210-foot medium endurance cutters will close out this aspect of Deepwater's C4ISR modernization effort to bridge the gap until new platforms enter service.

These upgrades were performed in conjunction with similar Deepwater C4ISR modernization ashore. The first shore-based Deepwater communications upgrade was completed in September of 2003 at Communications Area Master Station Atlantic (CAMSLANT). The Communications Area Master Station Pacific (CAMSPAC) facility at Point Reyes, California, which supports the Coast Guard's Pacific assets, also received the same upgrade in early 2004. Such installations form the cornerstone for enabling enhanced operational effectiveness for the Coast Guard's legacy fleet even as new IDS platforms with more capable C4ISR systems are designed for the future.

Operational Analysis

It would be impossible to translate the Deepwater Program from vision to reality without relying on a disciplined approach to its systems engineering.

In the view of Program Executive Officer RADM Patrick M. Stillman, Deepwater's systems-engineering strategy must, of necessity, encompass multiple dimensions -- an interdisciplinary process for developing, optimizing, implementing and maintaining an incredibly complex system in a way that is cost efficient, reduces risk, and makes schedule commitments for cost and delivery more reliable.

"Deepwater's systems engineering is a multifaceted process aimed at achieving cradle-to-grave excellence across the life of our system of systems -- from the conceptual design of Deepwater platforms and supporting systems to their eventual disposition at the end of their service lives," he said. This iterative, spiral progression is focused squarely on stakeholders' needs -- to establish mission and capability requirements using objective measures and desired outcomes; to identify, analyze and implement alternative solutions; and to achieve dramatic improvements in system interoperability and efficiency.

The critical component of the ICGS approach is operational analysis of the effectiveness of varied force structures, tactics, procedures, techniques and combinations of C4ISR systems. Modeling and simulation tools allow ICGS systems engineers to determine the optimum force configuration to meet the Coast Guard's performance goals, operational requirements and cost constraints.

Extensive studies examined all Coast Guard mission areas -- including maritime security, safety and mobility, national defense and protection of natural resources. These studies produced today's planned Deepwater system of systems of platforms, C4ISR and integrated logistics -- a system tailored to the Coast Guard's five principal regions (Northeast, Southeast, Western, Alaska and International).

This complex analysis takes into account detailed operational modeling of platforms and systems, optimized force mixes of varying size, asset applications using various concepts of operation and timed incremental implementations across the life of the program.

Deepwater's new platforms, like the Maritime Security Cutter, Large, will benefit from the application of spiral-development design principles in acquisition planning, a key aspect of Deepwater's systems-engineering process. NGSS

A Structured Approach

ICGS adheres to a structured, systems engineering approach to evaluate alternative system designs and conduct related studies. This process identifies optimum solutions balancing total ownership cost (for procurement, integration, operations, maintenance, technology refreshment and personnel), operational effectiveness (system performance for threat negation, incidence prevention or reduction and interoperability) and sustainability (training, maintenance, logistics, procedures and obsolescence).

The multifaceted system engineering process entails performance evaluations across the system, subsystem and component levels to analyze products and capabilities for both interoperability and system synergy to allow engineers to predict total system performance for numerous configurations (e.g., types and capabilities of assets, numbers of platforms, C4ISR architecture, etc.) and scenarios.

The ICGS team also applies an orderly systematic analysis to C4ISR development and integration that is open to various solutions in a "best-of-breed" approach.

Numerous modeling and simulation tools are integrated to allow comparison of the overall performance of the Deepwater system of systems to that of today's legacy force.

The integration of various Coast Guard legacy platforms and systems presents a highly complex challenge in system design. Initial Deepwater implementation, as well as subsequent upgrades and enhancements, must be addressed even as current operations continue at a high tempo and new missions evolve.

The Coast Guard-ICGS approach to systems engineering ensures that the Deepwater system of systems model retains the flexibility to be adapted to changing circumstances -- like the accelerated modernization of legacy platforms experiencing unacceptably high system failures- or changes in requirements. The wisdom of this methodology was validated most recently with the Coast Guard's completion of a "performance-gap analysis" addressing post-9/11 requirements.

Pathway to the Future

Since 9/11, the Coast Guard's mission demands, threats and operational priorities have changed considerably -- including a 40 percent increase in resource usage and an exponential expansion of homeland security requirements. A comprehensive analysis of the Coast Guard's post-9/11 operational capability and capacity gaps in today's homeland-security environment documents a compelling need to revise the Deepwater Implementation Plan to address these circumstances and to align the program with the Department of Homeland Security's strategic goals. The Coast Guard recommendations to revise the Deepwater Implementation Plan to address today's requirements will be proposed to the Department of Homeland Security as part of the Fiscal Year 2006 budget process.

Because of this need to remain flexible and responsive over the life of the program, the Deepwater system engineering strategy relies on spiral development to respond to evolving technology or changes in mission requirements.

Spiral development establishes requirements in an iterative process, by partitioning capabilities that can be defined, developed, refined and matured without causing rippling dependencies among other capabilities. The spiral process encourages in-stream improvement and refinement that allows system developers to upgrade capabilities incrementally until the system fully meets customer expectations.

Each spiral can accommodate successive iterations of requirements development and solutions testing, starting from broad aspects and progressing (i.e., spiraling) toward more specific aspects.

Customer feedback from Coast Guard operators -- in the form of cutter patrol summaries, Area-commander assessments and technical-performance measures -- will continue to be used to assess system performance as it evolves.

For Deepwater, reevaluation is an essential part of the spiral-development process so that changing needs, missions and new technology can be incorporated into the system of systems over the life of the program. Unlike many major acquisition efforts, the Coast Guard has designed and is implementing a program that will result in unprecedented levels of capability at costs lower than could be achieved using a "one-asset-at-a-time" recapitalization approach.

In today's complex, interconnected world, sound systems engineering is the pathway to the Coast Guard's future -- the means that will enable the Deepwater network-centric, system of systems to serve as a model for other major acquisition programs for many years to come.

Mark D. Gaspar is an engineer assigned to Lockheed Martin Corporation's Washington Operations. Capt. Gordon I. Peterson, USN (Ret.) is a technical director with the Anteon Corporation. ST

2004, and a 66 percent ($2.5 billion) increase over 2001 levels. As part of funding for Coast Guard programs, the appropriations bill includes $724 million for the Deepwater multi-year acquisition to modernize and recapitalize the Coast Guard's inventory of cutters, aircraft and supporting systems.

The $724 million congressional appropriation for Deepwater is $46 million more than the President's request of $678 million and $56 million above the FY 2004 appropriation of $668 million. "We recognize and greatly appreciate the strong support demonstrated by the Department of Homeland Security, the administration, and the Congress in advancing Deepwater's urgently needed recapitalization of the Coast Guard," said RADM Patrick M. Stillman, Deepwater's Program Executive Officer.

The appropriation will fund critical Deepwater Program initiatives to develop network-centric C4ISR (command, control, communications, computers, intelligence, surveillance and reconnaissance), continue development of integrated logistics support, recapitalize the Coast Guard's aging inventory of obsolete cutters and aircraft, and modernize aging legacy assets until new platforms enter service in future years. "The Deepwater Program is the future of the Coast Guard," said ADM Thomas H. Collins, Commandant of the Coast Guard, recently.

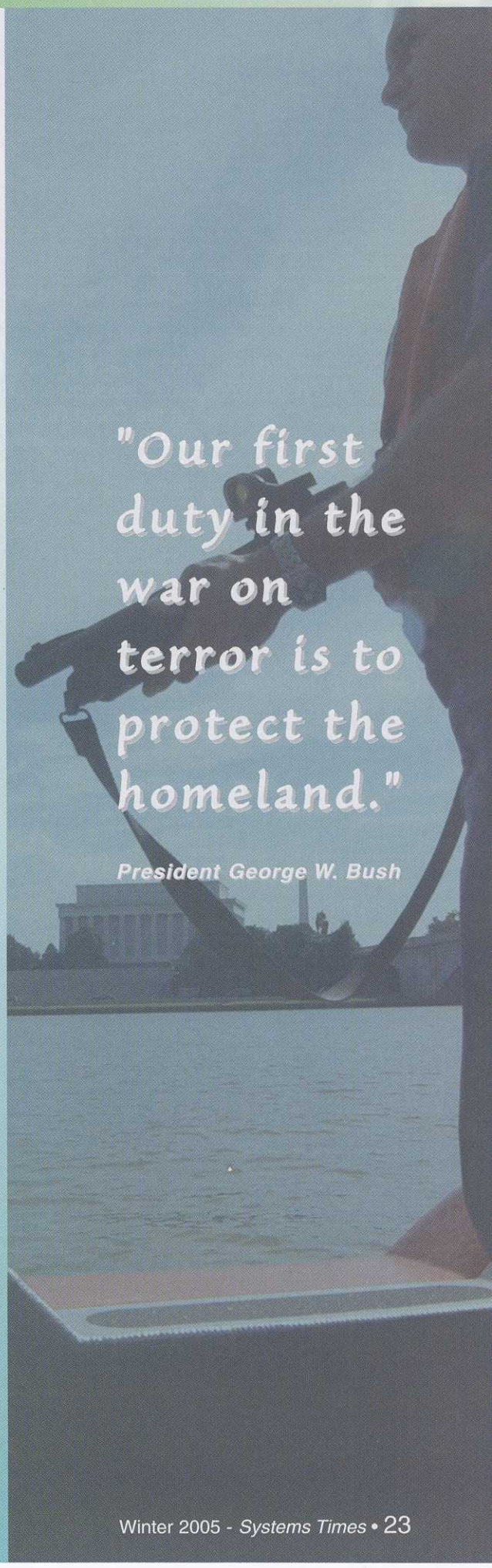
Deepwater Gaining Momentum

In an "ALCOAST" message to the Coast Guard on September 28, ADM Collins reaffirmed his guidance and focus on Deepwater's trackline. "Bringing Deepwater's system-of-systems acquisition to life is an extraordinary challenge," he said. Despite the continuing threat to mission performance presented by aging aircraft, boats, and cutters, the Commandant explained how the Deepwater Program is gaining momentum in a number of important ways.

"We have commenced immediate re-engining of HH-65 helicopters, accelerated the maritime patrol coastal (WPC, formerly the fast response cutter) to replace existing deteriorating Island-class patrol boats, expedited C4ISR upgrades to selected legacy cutters, and moved ahead smartly with the design of the maritime security cutter, medium (WMSM, formerly the offshore patrol cutter), the platform slated to replace our medium endurance cutter fleet," Collins said.

In recent months, the first re-engined HH-65C helicopter completed successful flight testing, a contract was awarded to Integrated Coast Guard Systems (ICGS) to begin preliminary design and final-requirements work on the WMSM with the goal of advancing the cutter's launch by three years, and fabrication of the maritime security cutter, large (WMSL, formerly the national security cutter) began in early September 2004.

"In just a few years," the Commandant said, "the Coast Guard will accept delivery of its first new 21st-century cutters. The sooner we get more reliable, more interconnected assets, the sooner they contribute to restoring and improving operational readiness and capacity commensurate with our critical mission set."



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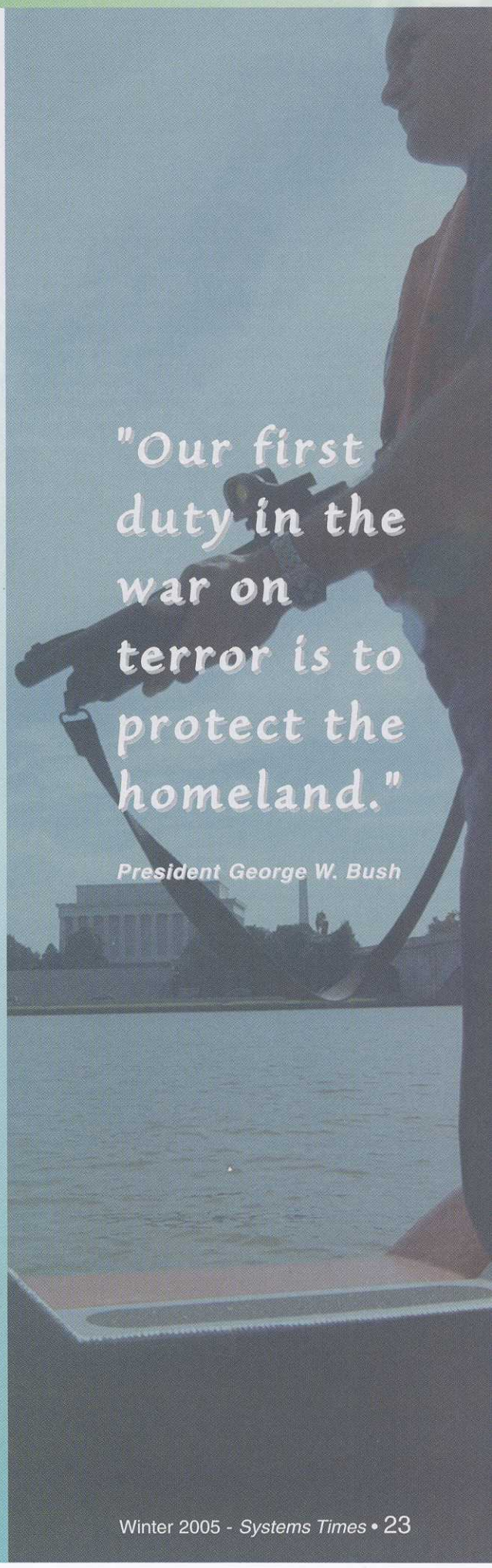

Coast Guard Delivers First Re-Engined HH-65 Helicopter

by PAC Jeff Murphy
Integrated Deepwater System

The Coast Guard, in partnership with Integrated Coast Guard Systems (ICGS) team (a joint venture between Lockheed Martin and Northrop Grumman), successfully delivered the first re-engined HH-65C "Dolphin" helicopter on October 7th to Aviation Training Center, Mobile, Alabama. The helicopter's initial development, design, and flight-testing took place at the Coast Guard's Aircraft Repair and Supply Center (ARSC) in Elizabeth City, North Carolina. This is the first Coast Guard production aircraft to receive a new system under the Integrated Deepwater System Program.

During the past seven years, Coast Guard aircrews reported more than 80 mishap reports concerning in-flight engine failures on board HH-65 helicopters. Although necessary steps were taken to address immediate concerns and correct many of the problems, the safety-of-flight issue required a Coast Guard-wide overhaul of the fleet workhorse.

In compliance with identified system-performance specifications developed earlier this year, the Coast Guard requested ICGS take immediate and definitive action to re-engine the HH-65 fleet, a feat achieved in 111 working days from the start of work to flight operations. The conversion of an HH-65B helicopter to HH-65C helicopter will require an estimated three months.

Currently, ARSC personnel are in the process of re-engining and modifying all 95 Coast Guard HH-65 helicopters into "C" model helicopters. As HH65A aircraft enter Periodic Depot Maintenance at ARSC, they will be converted from HH-65A into an HH-65C. This process will also incorporate all HH-65B upgrades currently being implemented. Additionally, all HH-65B aircraft currently in the fleet will undergo a modification process to upgrade it to an HH-65C.

This first production HH-65 helicopter incorporating Deepwater upgrades entered full operational service at Aviation Training Center, Mobile, Alabama, in early October. Modification of the first ready-response HH-65 will be completed in early December 2004, and it will be assigned to HH-65 prime unit, in Atlantic City, New Jersey, which serves as the operational center for new maintenance procedures and testing development.

The modernization effort includes the provisioning of kits to re-engine the twin-engine helicopters with the more powerful Turbomeca Arriel 2C2-CG engine. Enhancements include optimized heat shields beneath the exhaust system and installation of a reconfigured control panel featuring a digital fuel control system conversion.

In addition to the new digital electronic engine control system, other upgrades include beefed-up gearboxes, tone-emitting warning systems (vice lights-only), and simplified instruments. The physical appearance of the Dolphin remains the same with the addition of a protective heat shield beneath the exhaust stack of the engine and an extended nose with a larger battery. Inside, the aircraft's main instrument console has been simplified.

The Deepwater Program's HH-65 helicopter modernization effort at Coast Guard's Aircraft Repair and Supply Center in Elizabeth City, NC, includes the re-engining of the twin-engine helicopter with the Turbomeca Arriel 2C2-CG engine and numerous other upgrades. Photo by PAC Jeff Murphy, USCG

The transition from earlier model helicopters to HH-65C helicopter will require a two-week training syllabus with both ground and flight sessions. Training courses are planned for maintenance mechanics in the operation and repair of this new system. The Dolphin's flight simulator at Aviation Training Center (ATC) Mobile and the Maintenance Training Unit at ATC Elizabeth City are also scheduled for update.

An Emphasis on People

ADM Collins also emphasized in his recent Coast Guard-wide message on the Deepwater Program that the Coast Guard will ensure that it has the right level of manning and support systems in place to maximize Deepwater's operational effectiveness while minimizing total ownership costs. "The one system we must absolutely get right is the people piece," he said.

The Commandant encouraged officers in command at all levels to continue to provide Deepwater's Program Sponsor's Office at Coast Guard Headquarters with data and recommendations relating to emerging operational and personnel trends. Such inputs are captured regularly through screening of cutter patrol summaries and regular program teleconferences and visits with both the Atlantic and Pacific Area Commanders.

"Keep the flow of ideas from the deckplates coming," said ADM Collins. "Your ideas can be reflected in new requirements that will work their way through an established requirements-change process that enables deliberate review at the highest levels."

The current review of the Coast Guard's proposed budget for Fiscal Year (FY) 2006 will play an important role in determining the Deepwater Program's future scope and implementation.

Following a performance-gap analysis and other assessments of the Coast Guard's post-9/11 requirements, a revised Deepwater mission need statement and implementation plan were finalized in recent months. They were proposed to the Department of Homeland Security in early October and, following approval by the department's Joint Requirements Council, submitted to the Office of Management and Budget in mid-October as part of the federal budget process for FY06.

"Our objective is to acquire needed, affordable capabilities to safeguard the security of the nation and safety of our citizens while being fully responsive to the needs of our people and mission requirements," ADM Collins said. "Keeping Deepwater on track is one of my highest priorities." ST